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TEMPERATURE EXTREMES IN OHIO DURING 1981[1]

DAVID H. HICKCOX, Department of Geography and Geology, Ohio Wesleyan University, Delaware, OH 43015

ABSTRACT. Using 1981 temperature data for Ohio, the maximum and minimum temperatures for each day were analyzed to reveal the spatial relationships of extreme temperature distributions. The range of temperature reflected normal variations in solar insolation as well as the invasion of warm and cold air masses. The spatial distribution of extreme temperature points out the control of latitude and elevation on temperature. The occurrence of maximum and minimum temperature was concentrated in specific areas, suggesting hot and cold regions.

OHIO J. SCI. 84 (1): 11-15, 1984

INTRODUCTION

Ohio's climate is classified as a humid-continental type (Noble and Korsok 1975). A salient characteristic of this type of climate is a pronounced seasonal shift of temperatures ranging from frigid temperatures in the winter to torrid summertime temperatures above 38C. Indeed, the extreme temperatures recorded in Ohio range from a minimum of −39.4C to a maximum of 45C (Goddard 1979). On a yearly basis the range of temperature is less. During an average year Ohio will experience about 5 days of temperatures below 18C and will record maximum temperatures between 36C and 38C (National Oceanic and Atmospheric Admin. 1982). Of particular interest is the range of maximum and minimum temperatures through the course of a year. Just how hot and how cold is it in Ohio during an average year and what locations are the hottest and coldest? This paper examines the maximum and minimum temperatures recorded in Ohio during 1981 emphasizing the daily range of the maximum and minimum and, especially, the spatial distribution of extreme temperatures. The range of temperatures recorded in 1981 reflects an average year with the exception of a cold spell occurring in early February.

METHODS AND MATERIALS

There are 108 weather stations in Ohio which record temperature (table 1, fig. 1). These stations are fairly evenly distributed geographically and are located in each type of environment occurring in Ohio. The temperatures for all 108 stations are published monthly in *Climatological Data, Ohio* by the National Climatic Center in Asheville, NC. The highest and lowest temperature occurring in Ohio for each day was determined and plotted upon a graph and then mapped using circles mathematically proportional to the number of times a location was Ohio's hot or cold spot. This readily revealed the spatial distribution of Ohio's high and low temperatures, allowing for analysis.

RESULTS AND DISCUSSION

The highest and lowest temperatures in Ohio for each day of 1981 are shown in

TABLE 1

Ohio's temperature recording stations by geographic regions.

Region*	Number of Stations Recording Temperature
Northwest	14
North central	10
Northeast	13
West central	7
Central	14
Central hills	11
Northeast hills	5
Southwest	14
South central	8
Southeast	12

*Standard regions for Ohio developed and used by National Oceanic and Atmospheric Admin.

[1]Manuscript received 12 January 1983 and in revised form 25 February 1983 (#83-2).

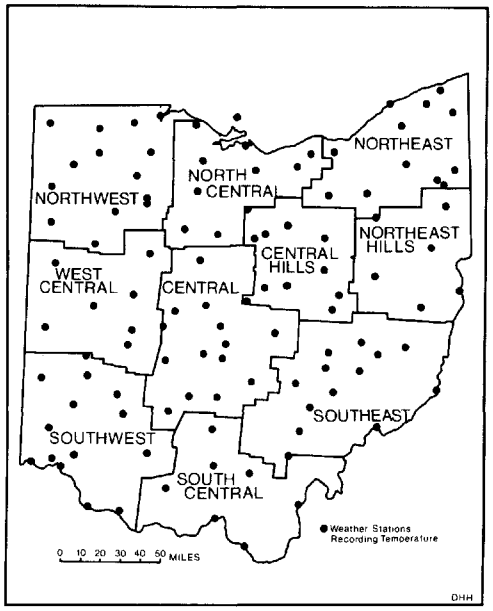

FIGURE 1. Stations recording temperature in Ohio and standard Weather Bureau geographic regions.

fig. 2. The graph reflects not only the expected seasonal variations of solar insolation but also, to some degree, the peculiarities of 1981's weather (Hickcox 1982).

During January the minimum temperature remained below −18C until 19 January 1981. The coldest temperature recorded in Ohio during 1981 was −31C recorded at Wauseon on 4 January, 16 degrees warmer than Ohio's coldest recorded temperature, −39.4C recorded at Milligan on 10 February 1899 (Ludlum 1982). Following a late-January warming trend temperatures once again plummeted to below −18C during the first 2 weeks of February. Temperatures moderated rapidly following this cold spell, and the first minimum temperature above 0C was recorded on 18 February with a 2C reading at McConnelsville Lock. This warming trend was short-lived, however, and the low temperatures remained below freezing the remainder of February, all of March, and it was not until April that above freezing minimum temperatures were recorded with any regularity. The last below freezing temperature was −1C recorded at Dorset on 1 June. Minimum temperatures during the summer ranged from above 5C and below 15C during June, between 10C and 20C in July, and edged back between 5C and 10C in late August. The highest minimum temperature recorded in Ohio in 1981 was 18C at McConnelsville Lock on 15 June. Minimum temperatures declined during September and the first below freezing temperature of the fall season was −1C recorded in Montpelier on 23 September. By October the low temperature ranged from −7C to −1C and occasionally was lower. Temperatures below −18C were first recorded in late December.

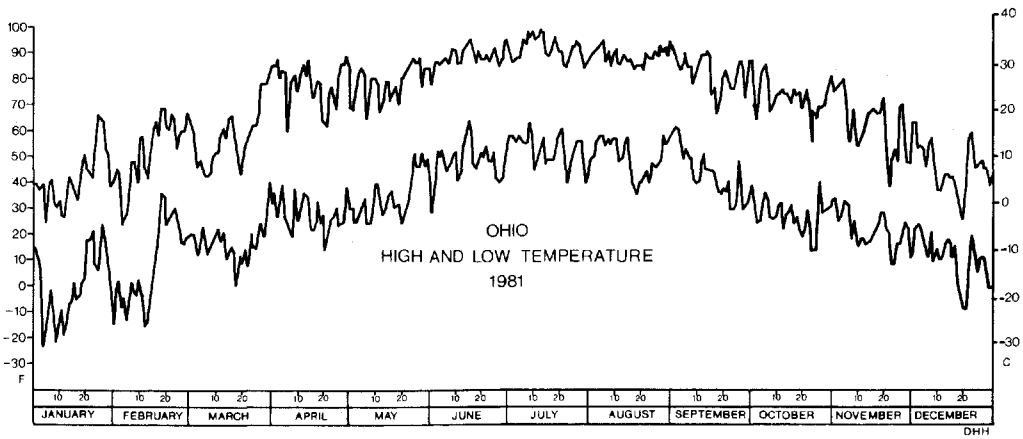

FIGURE 2. High and low temperatures in Ohio during 1981.

The daily high temperatures show the same general trend as the low temperatures. High temperatures, with 4 exceptions, remained above freezing during January and a late-January warming trend pushed maximum temperatures above 15C, with 19C recorded at Waverly on 25 January. Following an early February cold spell, maximum temperatures were between 10C and 20C the remainder of the month and during March. Early April temperatures were above 26C with 31C recorded at Marion on 2 April and continued between 20C and 30C for the rest of the month. Maximum summer temperatures ranged from 26C to 37C with the highest temperature in Ohio in 1981 being 37C recorded at the office of the Toledo Blade in downtown Toledo on 8 and 10 July, and at Cincinnati-Fernbank on 14 July. This was well below the state record of 45C recorded near Gallipolis on 21 July, 1934 (Ludlum 1982). Maximum temperatures remained warm the remainder of the summer, and it was not until October that they dipped below 21C. Year's end brought maximum temperatures ranging from 4C to 15C.

The distribution of Ohio's coldest and hottest temperature is heavily influenced by latitude. Basically, the coldest temperatures occur in the northern portion of the state, and the warmest temperatures are found in southern Ohio. However, to fully understand the spatial distribution of temperature extremes the vagaries of Ohio's geography must be taken into account.

Elevation is an important control of temperature. As elevation increases, temperature decreases at an average rate of about 6C per 1,000 m (Strahler and Strahler 1978). Thus higher areas, such as north-central and northeastern Ohio, tend to have relatively colder temperatures, while lower areas, such as along the Ohio River, tend to have warmer temperatures. In areas of highly dissected terrain, such as in the Appalachian Plateau of eastern and southeastern Ohio, cold air, being denser than warm air, tends to drain into valley bottoms. This accounts for minimum temperatures occurring at locations such as McConnelsville Lock and Tom Jenkins Lake.

Lake Erie has an important impact on northern Ohio temperatures. Large bodies of water absorb solar radiation more readily than land surfaces and the radiation diffuses throughout the upper portion of the water mass. Thus temperatures of water masses are cooler in summer than land surfaces (Patton et al. 1974). The Ohio coastline is cooler than adjacent inland areas during the summer, and only seldom does a coastal community record the statewide summer maximum temperature. Conversely, the lake's stored heat is released slowly as winter approaches, sparing the coast extreme cold temperatures. (The effect of Lake Erie on coastal temperatures is the reason for the location of numerous vineyards along the lake.)

In 1981 concentrations of low temperatures occurred in northwestern Ohio, the highlands of north-central Ohio and northeastern Ohio, and in the valleys of southeastern Ohio (fig. 3). Obviously the farther north a location, the greater propensity for cold temperatures. However, low temperatures seldom occurred along the Lake Erie shore. The concentration of low temperatures in northwestern Ohio is due to the fact that the influence of Lake Erie is not felt this far westward. Thus the area receives the full impact of cold air moving into the state from the north. The glaciated portion of the Appalachian Plateau in north-central and northeastern Ohio experience cold temperatures due to their northerly latitude and relatively high elevations. The weather station at Plymouth, Ohio's coldest weather station in 1981, is located at 293 m and that at Dorset, the second coldest station, at 299 m. The coldest temperature in Ohio can occur at almost any weather station in the state, but note that large cities rarely received the distinction of recording Ohio's coldest temperature. Temperatures within cities are generally higher than in rural areas due

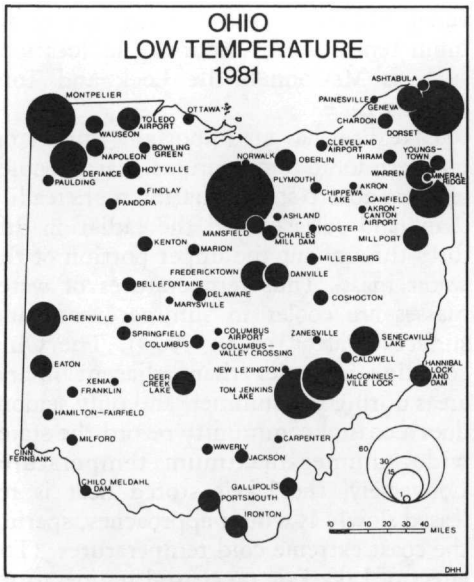

FIGURE 3. Weather stations recording daily minimum temperatures during 1981. Size of circles is mathematically proportional to the number of times a weather station recorded Ohio's lowest daily temperature.

to the cities' concrete and asphalt absorbing and storing greater quantities of solar radiation than the vegetation and soils of rural areas (Lutgens and Tarbuck 1979). The term applied to this phenomenon is the "urban heat island." Thus, places such as the Toledo airport, the Cleveland airport, the Columbus airport, and Cincinnati-Fernbank, all on the fringes of urban areas, occasionally recorded minimum temperatures, but rarely did stations downtown record such cold temperatures.

Table 2 lists the top 10 cold spots in Ohio during 1981. Plymouth was the coldest location, recording Ohio's minimum temperature 56 times. Dorset was the second coldest location with 40 minimum readings and Montpelier and Tom Jenkins Lake were tied for third, each recording the minimum temperature 34 times. Six of the 10 stations are located in northern Ohio.

Ohio's high temperatures are much more concentrated in their distribution than the cold temperatures and reflect

TABLE 2

Top 10 cold spots in 1981.

Location	Number of Occurrences
1. Plymouth	56
2. Dorset	40
3. Montpelier	34
4. Tom Jenkins Lake	34
5. Canfield	25
6. McConnelsville Lock	24
7. Defiance	21
8. Greenville	16
9. Senecaville Lake	13
10. Warren	13

strong control by latitude and an influence by the urban heat island effect (fig. 4). Obviously, the more southerly location of a weather station, the more solar insolation received. Also, Ohio's southerly cities along the Ohio River are among the lowest elevations in Ohio. Thus they have a maximum amount of the heat-absorbing atmosphere above them. A

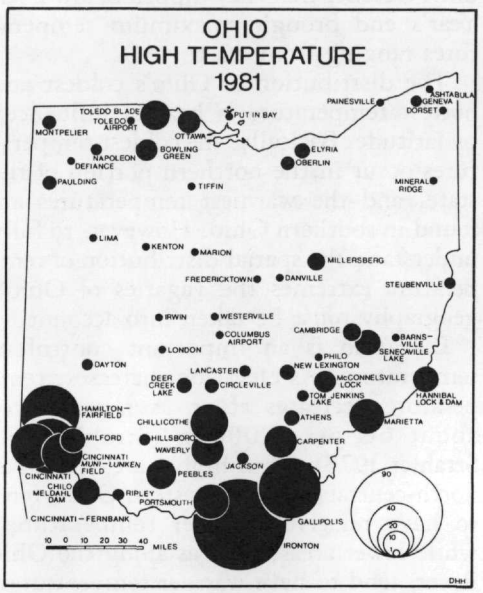

FIGURE 4. Weather stations recording daily maximum temperatures during 1981. Size of circles is mathematically proportional to the number of times a weather station recorded Ohio's highest daily temperature.

small concentration of high temperatures occurs in northwestern Ohio, again illustrating the lack of influence by Lake Erie. These occurred primarily in the summer months when a high pressure system was located over northern Ohio and low pressure was located over southern Ohio. High pressure causes a convergent flow of air aloft causing the air to sink. This is conducive to air stagnation and the build-up of high temperatures.

The urban heat island effect has an impact on Ohio's high temperatures. Urban areas in southern Ohio, especially Ironton, Gallipolis, and in the Cincinnati metropolitan area, recorded the majority of Ohio's hot temperatures. Toledo provides an excellent illustration of urbanization's impact on temperature. The weather station located at the Toledo Blade recorded Ohio's hottest temperature 13 times, while the Toledo airport, located outside of the city, recorded the warmest temperature only once.

Ironton has the distinction of being Ohio's hottest city (table 3), recording the warmest temperature 93 times. This means that, on the average, Ironton was the warmest location in Ohio once every 4 days. Gallipolis was the second hottest location, recording Ohio's warmest temperature 46 times. Hamilton-Fairfield was third with 42 occurrences and Cincinnati fourth with 40 high readings. All but one of Ohio's top 10 hot spots are located in southern Ohio.

In summary Ohio's temperature ranged from a minimum of −31C to a maximum of 37C in 1981. These extremes reflected the normal range of temperature due to changing amounts of solar radiation. The spatial distribution of extreme temperatures shows concentration of cold temperatures in northwestern, north-central and northeastern Ohio with a minor concentration in the valleys of southeastern Ohio. Maximum temperatures showed a much greater concentration. Weather stations in southern Ohio and especially in urban locations along the Ohio River accounted for the overwhelming majority of maximum temperature readings. The spatial patterns of extreme temperatures delineate concentrations of hot and cold temperatures in specific areas.

TABLE 3

Top 10 hot spots in 1981.

Location	Number of Occurrences
1. Ironton	93
2. Gallipolis	46
3. Hamilton-Fairfield	42
4. Cincinnati	40
5. Cincinnati-Fernbank	26
6. Chillicothe	19
7. Cincinnati Muni-Lunken Field	18
8. Marietta	17
9. Portsmouth	17
10. Toledo Blade	13

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